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To appear in W. Schmitz, ed., *Proceedings of the 7th International Congress of the IASS-AIS*, Thelem, Dresden, 2001, 11-23

Peirce on Complexity

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Keep it simple, stupid!
U. S. Army manual from the 1950s.

1. Introduction[1]

In a world of ever growing specialization, the issue of complexity attracts a good amount of attention from cross-disciplinary points of view. The size of this huge Congress confirms this. Indeed, it would seem that the idea of the unity of science, which is commonly discarded as an impossible ideal, is enjoying a strong comeback. But, lest we fall back into some sort of positivistic utopia, it may be useful to listen to some of the suggestions which were made by Charles S. Peirce. It is my conviction that Peirce's thought may help us not only to reassume our philosophical responsibility which has been largely abdicated by much of 20th century philosophy, but also to tackle some of the most stubborn contemporary problems (Debrock 1992: 1). More specifically, the founder of pragmatism not only identified most of these problems one century ago, but he also mapped out some paths that we could follow to overcome the poverty of contemporary scientistic reductionism. One of these paths is related to the issue of complexity, that lies at the heart of all his thinking, and which forms the topic of my paper.

The aim of my paper is to describe what Peirce can teach us, semioticians coming from very different scientific backgrounds, about complexity. My presentation is motivated less by some tedious scholarly purpose, than by a wish to present to non-Peircean scholars some suggestions made by Peirce which may in turn inspire us to elaborate upon his train of thought. In this regard I try to follow the difficult "Law of KISS", the modern version of Occam's razor very well-known to software developers and engineers, "Keep it simple, stupid". I mention it, not merely to entice the audience into a smile, but as a matter of philosophical responsibility. With that purpose in mind, my paper is divided in three sections: 2) a presentation of Peirce, stressing his personal authority as a scientist philosopher, and providing also some biographical details; 3) the theory of categories as the heart of his view of complexity and, finally, 4) some consequences of Peirce's notion of complexity in relation to creativity, semiosis, cross-disciplinarity and communication.

[1] Thanks are due to John Deely and Lúcia Santaella for their invitation and for choosing the topic of my lecture. I am indebted also with Fernando Andacht, Sara Barrena, Dave Bohnstedt, Ruth Breeze, Alejandra Carrasco, María Cerezo, Nathan Houser, Carl Hausman, Antonio Peláez, and Carlos Pérez for their suggestions and their help.

2. Charles S. Peirce, a true scientist philosopher

The influence and the relevance of the work of Charles S. Peirce for very different areas of knowledge is increasingly being recognized (Fisch 1980; Wright 1993: 41): in astronomy, metrology, geodesy, mathematics, logic, philosophy, theory and history of science, semiotics, linguistics, econometrics, and psychology. In all these fields Peirce has been considered a pioneer, a forerunner or even a 'father' or 'founder' (of semiotics, of pragmatism). Superlative evaluations of his contribution are not uncommon. Thus, Russell states that "beyond doubt ... he was one of the most original minds of the later nineteenth century, and certainly the greatest American thinker ever" (Russell 1959: 276). Similar quotations may be found in the work of Umberto Eco (Eco 1989: x-xi), Karl Popper (Popper 1972: 212), Hilary Putnam (Putnam 1990: 252), and many others.

Among the major factors that have furthered the growing interest in Peirce's thought are his personal participation in the scientific community of his time, his valuable contribution to the logic of relatives, and his sound knowledge of the philosophy of Kant as well as of the Scholastic tradition, in particular Duns Scotus' philosophy. Thus Peirce has been considered not only a forerunner of contemporary analytic philosophy (Hookway 1985: 141; Wright 1993: 41), but also as a milestone in the semiotic transformation of transcendental philosophy (Apel 1981), and even as a renovator of the Aristotelian tradition which played a central role in the development of Western philosophy (Beuchot and Deely 1995; Gracia 1993).

All of this is commonplace in the present revival of the scholarship on Peirce. The point I want to stress, however, is that, though Charles S. Peirce was a philosopher and a logician, he was first and foremost a real practitioner of science. Not only was he trained as a chemist at Harvard, but for thirty years (1861-91) he worked regularly and strenuously for the U. S. Coast Survey as a metrologist and as an observer in astronomy and geodesy. His reports to the Coast Survey are an outstanding testimony to his personal experience in the real hard work of measuring and obtaining empirical evidence. A glance at his official reports to the Coast Survey or at his *Photometric Researches* produced in the years 1872-75 inmediately confirms the impression of a man involved in solid scientific work (*W* 3: 382-493, 1878). As Max Fisch points out, "Peirce was not merely a philosopher or a logician who had read up on science. He was a full-fledged professional scientist, who carried into all his work the concerns of the philosopher and logician" (*W* 3: xxviii-xxix).

Peirce's scientific work was precisely the reason for his visit to Dresden in the summer of 1870. The circumstances of that journey bear witness to the wide scope of his interests. Let us dwell on this for a moment. In 1861, when finishing his studies at the Lawrence Scientific School at Harvard, Peirce was hired as an assistant to his father, Benjamin, in the Coast Survey, which was the American government's principal scientific body at that time. In 1869, he was a member of one of the teams in Kentucky studying the total eclipse of the sun on August 7th (*W* 2: 290-293, 1869). The telescopic observation of the solar corona and its protuberances, and the detection of helium by means of the spectroscope, led the American astronomers to formulate new theories regarding the composition of the sun, that were received with a certain skepticism by European astronomers (*W* 2: xxxii).

As no other such favorable occasion was going to arise in the nineteenth century, Benjamin Peirce, the third Superintendent of the Coast Survey, obtained an appropriation from the Congress to organize an expedition to observe the next solar eclipse, which was to take place at midday on December 22, 1870 over the Mediterranean Sea. In order to ensure the success of the project, he sent his son Charles to Europe six months beforehand, to prepare the expedition. Charles traveled from London to Constantinople, via Rotterdam, Berlin, Dresden, Prague, Vienna and Pest. From Constantinople he then scouted the entire path of totality of the eclipse from East to West in search of locations suitable to observe the phenomenon.

There is a nice letter from Peirce to his brother James *from* Dresden. It was written on 11 August 1870 and begins: "Amy and I arrived last evening . . . " Amy was his wife's sister who at the time was studying music in Germany. Peirce tells his brother that they are

> ... not at the Bellevue but at Weber's which though not situated like the other has a very pleasant location near the Zwinger & where we hear a band in the evening & we have the best rooms in the house & the bill which is brought up daily is so moderate as to act as a sedative upon the nerves all day...

He concludes his letter by saying "I should like very well to stay here with her a week where I am having the most delightful time but I cannot say I think my health requires it at all." (*L* 339[2]). Then on the 21st of August Amy Fay wrote from Berlin to Zina:

> I suppose that C. has described to you in full our Dresden visit, and what a lovely time we had. It was really a poetic five days, as everything was new to both of us. We were a good deal surprised at many things in Dresden. In the first place, the beauty of the city struck us very forcibly, and we both remarked how singular it was that of all the people we know who have been there no one should have spoken of it.

Amy goes on with a great deal of description. At one point she writes "It seemed like fairy land, as we sat there in Dresden."[3]

Though I will not dwell upon the details of Peirce's visit to Dresden, there is no doubt that their delightful impression was very similar to the one we have now! When the time came, Charles S. Peirce joined one of the two groups of American scientists in the observation of the eclipse. His group included his wife Zina and his father Benjamin observed the eclipse in the vicinity of Catania (Sicily). Although the day turned out to be cloudy and even somewhat rainy, the observations made by both expeditions were successful, and confirmed the conclusions drawn by the Americans on the basis of the previous eclipse. As Joseph Brent wrote, "this expedition was Charles's first experience of large-scale international scientific

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[2] The letter is kept in the Houghton Library at Harvard. Robin, R. *Annotated Catalogue of the Papers of Charles S. Peirce*. Amherst, MA: University of Massachusetts Press 1967.

[3] I am really very indebted with Nathan Houser, director of the Peirce Edition Project at Indianapolis, for all the information related with Peirce's visit to Dresden. Amy Fay's letter is published in her *Music-study in Germany. From the Home Correspondence of Amy Fay*. Chicago: Jansen, McClurg & Co 1883, 5th ed., 86-88. "Unfortunately -adds Houser- we don't have Peirce's letters to Zina which is where his most descriptive efforts would have gone."

cooperation, and it illustrated for him the importance of the community of science in reevaluating and validating its hypotheses" (Brent 1993: 80; *W* 2: xxxiv)[4].

It was on the basis of his first experiences as a young scientist that Peirce came to believe that the community of inquirers was essential for scientific rationality. For him, science can flourish only in the context of research communities: the pursuit of truth is a corporate task and not an individual search for foundations. As Peirce wrote in *The Ethics of Terminology*, "the progress of science cannot go far except by collaboration; or, to speak more accurately, no mind can take one step without the aid of other minds." (*CP* 2.220, 1903). This communitarian perspective upon scientific activity, as Bernstein remarked, "not only challenges the characteristic Cartesian appeal to foundations, but adumbrates an alternative understanding of scientific knowledge without such foundations" (Bernstein 1983: 71-72).

The interpretation of Peirce's thought and its evolution from his early writings in 1865 until his death, for many years provoked wide disagreement amongst Peirce scholars. This was due in part to the fragmentary presentation of his work in the *Collected Papers*, and in part to his going against the grain. The fact is that, as a philosopher, Peirce is not easily pigeon-holed: Some considered him a systematic thinker, but with four successive systems (Murphey 1961); others saw him as a contradictory thinker (Goudge 1950; Rorty 1996[5]), or as a speculative metaphysician of an idealist type (Esposito 1980). In recent years, however, a deeper understanding of the architectonic nature of his thought and of his whole evolution has been gaining general acceptance (Hausman 1993: xiv-xv; Houser 1992: xxix). In the last decade all Peircean scholars have clearly acknowledged the basic coherence and undeniable systematic unity of his thought (Santaella-Braga 1993: 401; Hausman 1993; Parker 1998).

Following Hookway to some extent (Hookway 1985: 1-3), I think that the most accurate understanding of Peirce is to see him as a traditional and systematic philosopher, but one deals with the modern problems of science, truth and knowledge from a very valuable personal experience as a logician and as an experimental researcher in the bosom of an international community of scientists and thinkers. In this sense, Peirce's personal participation in the scientific community of his time buttresses whatever he has to say about complexity from a philosophical point of view.

3. The categories at the heart of complexity

There is not yet a unified conception of complexity, nor, as Roberta Kevelson put it, "a common ground or a general unifying and synthesizing notion of complexity which can act as a referential principle for all various approaches" (Kevelson 1993: 265). Hoping that maybe Peirce might offer some suggestions, I

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4 In my paper, "C. S. Peirce and the Hispanic Philosophy of the Twentieth Century", *Transactions of the Charles S. Peirce Society* 24/1 (1998), 31-49 are available details of Peirce's visit to Spain.

5 In a long conversation in Stanford in August 1996 Rorty told me that he had "wasted" the first two years of his professional life as a philosopher trying unsuccessfully to make sense of Peirce's thought, and that he had given up his effort after reading Murphey's book. In spite of that comment, the young Rorty was the first philosopher to acknowledge the similarities between Peirce and the last Wittgenstein (Rorty 1961; Nubiola 1996: 281).

searched the electronic version of Peirce's *Collected Papers* for the term 'complexity'. To my surprise, a great deal of the 40 occurrences of the term "complexity" concerned protoplasm and the chemical complexity of its molecules (*CP* 1.393, c.1890; 6.246, 1891; 6.278, 1893; 6.283, 1893; 7.503, 1898; 1.351, c.1905). This fact strongly suggested to me that for Peirce complexity is in the first place related to the structure of the world, and only secondarily to our ways of understanding it and talking about it:

> It is a known law of mind, that when phenomena of an extreme complexity are presented, which yet would be reduced to order or mediate simplicity by the application of a certain conception, that conception sooner or later arises in application to those phenomena. (*CP* 5.223, 1868)

Though the term 'protoplasm' had been introduced by von Mohl in 1848, it had gained widespread acceptance under the influence of Huxley; and by the time of Peirce's writing, the study of the structure of protoplasm "the living substance of the cell, exclusive of the nucleus", had become the center of biological research and scientific debate (Baldwin 1901: II, 372). To Peirce, the chemist, the complexity of the protoplasm molecule was nothing less than "amazing" (CP 1.393, c.1890):

> The class of chemical substances having the most complicated molecules is, without doubt, that of the protoplasms. This chemical complexity is, in my opinion, sufficient to account for the extraordinary properties of those substances by virtue of which they grow into animals and plants. In particular, the laws of nervous action are, as I think, traceable to the chemical characters of the protoplasms of which the contents of nerve-cells are composed. (*CP* 6.278, 1893).

The typical properties of the protoplasm, "contractility, irritability, automatism, nutrition, metabolism, respiration, and reproduction [...] can all be summed up under the heads of sensibility, motion, and growth" (*CP* 1.393, 1887-88). For Peirce these can not possibly be fully explained or understood under the reductionist paradigm of mechanical physics, which does not allow us to fathom the phenomena of growth and increasing complexity:

> Question any science which deals with the course of time. Consider the life of an individual animal or plant, or of a mind. Glance at the history of states, of institutions, of language, of ideas. Examine the successions of forms shown by paleontology, the history of the globe as set forth in geology, of what the astronomer is able to make out concerning the changes of stellar systems. *Everywhere the main fact is growth and increasing complexity*. [...] From these broad and ubiquitous facts we may fairly infer, by the most unexceptionable logic, that there is probably in nature some agency by which the complexity and diversity of things can be increased; and that consequently the rule of mechanical necessity meets in some way with interference. (*CP* 6.58, 1891, emphasis added).

Even more amazing perhaps is the fact that Peirce considers the properties of protoplasm to be instrumental in our understanding of psychical activity, as the last words of the quotation above already suggest: "the laws of nervous action are, as I think, traceable to the chemical characters of the protoplasms of which the contents of nerve-cells are composed".

This approach was fully developed by Peirce in his manuscript "A Guess at the Riddle" of 1887-88, which "is perhaps Peirce's greatest and most original contribution to speculative philosophy" (*EP* 2: 245). In that paper Peirce described the three irreducible categories, which he originally derived from his logical studies, and later applied to all phenomena. In "A Guess at the Riddle" he illustrates the application of that triad to metaphysics, psychology, physiology, biology development, and physics.

We are getting to one of the central points of my presentation, which is also relevant to contemporary theories of mind and which reflects very well the naturalistic flavour of Peirce's revolt against Cartesian dualism typical of modern philosophy. His attempt to illustrate the nature and qualities of our mental activity by the properties of the protoplasm of the nerve-cells may —in my opinion— be compared to some research programs which try to explain what we human beings are by way of deciphering the genetic language of the chromosomes (Searls 1992; Eberling and Jiménez-Montaño 1980), or to some contemporary trends of functionalism in philosophy of mind in which attempts are made to understand our brains as sophisticated computers (Putnam 1988; Searle 1992). But the essential difference between Peirce's approach and these contemporary trends is that Peirce never tries to *reduce* complex phenomena to simpler ones, to a set of fundamental mechanical laws, but on the contrary he understands all phenomena in terms of the most general categories that an attentive study of experience yields. This is the essential point Peirce has taught us, as has been emphasized by the *new physics* (Anderson 1972; Arecchi & Farini 1996) or by the late novelist Walker Percy in his memorable *Jefferson Lecture* (Percy 1989).

If I want to be faithful to the 'law of KISS' which I mentioned at the beginning of this paper, I must now offer some additional explanation. First of all, a personal confession. When years ago I started to study Peirce, I tried to skip his three fundamental categories: Firstness, Secondness, and Thirdness, which some authors considered to be the core of his theory. Speaking of Firstness, Secondness, and Thirdness sounded to me as meaningless and unpalatable gibberish of a metaphysico-mathematical stripe. But eventually I came to see that not only it is impossible to make sense of Peirce without them, but, moreover, that these three categories were indeed Peirce's gift to the world (Debrock 1996).

The easiest access to the categories is by way of experience. All we need is to simply *look* at how *phenomena* appear. This is exactly what Peirce suggested by his choice of the word 'Phaneroscopy' (from the Greek words tó fanerón, which is synonymous to fainomenon, and skopein, which means 'to look at'). Such phaneroscopy "shows that the formal relations studied in mathematical logic have material correlates in experience" (Parker 1998: 105). Let us take an example of my feeling the solid surface of this desk: as feeling, it involves reactivity, opposition, and thus secondness. But how the two elements are related to each other so that there is the object which I call this desk, is a matter which Peirce calls thirdness. On the other hand, since secondness somehow presupposes that there are two elements involved, each of which is distinct from the other, the phaneroscopy must admit of Firstness which, in virtue of its sheer singleness is the most difficult aspect to describe:

> Indeed, strictly speaking it cannot be described without contaminating it with an element of thirdness. Firstness is that element of an appearance which does not refer to anything other than itself. The closest we may come to describe firstness is by attempting to think a sensation before we sense it (Debrock 1996: 1339).

In 1905, Peirce traced back the discovery of the three categories "after three years of almost insanely concentrated thought" to his paper of 1867, "On a New List of Categories". He summarizes his discovery of the categories as follows: "I examine the phaneron and I endeavour to sort out its elements according to the complexity of their structure. I thus reach my three categories". (*CP* 8.213, c.1905).

Charles Hartshorne and Paul Weiss organized a section of the first volume of Peirce's *Collected Papers* under the title "Protoplasm and the Categories", with three paragraphs of his *Logic Notebook* II of around 1905, where he explains how the three categories obtained from mathematics may be helpful in our understanding the function of protoplasm:

> As to protoplasm, what the three [...] *categories* [...] do, and what they are limited to doing, is to call attention to three very different characters of this chemical body. The first is a *posse* which it has in itself; for the *priman* stops at *can-bes* and never reaches to existence, which depends on interaction, or *secundanity*. This internal power which the category merely suggests, we recognize as that of feeling. [...] Next there is reactive force, a twoness, which is emphasized in the nerve cells together. It is the property by which any state of high cohesiveness tends to spread through the albuminoid matter. We usually call the property contractility. Thirdly, the categories suggest our looking for a synthetizing law; and this we find in the power of assimilation, incident to which is the habit-taking faculty. This is all the categories pretend to do. (*CP* 1.350-351, c.1905).

And this explanation concludes with the assertion that these categories

> [...] suggest a way of thinking; and the possibility of science depends upon the fact that human thought necessarily partakes of whatever character is diffused through the whole universe, and that its natural modes have some tendency to be the modes of action of the universe.

The naturalistic tendency of Peirce's mature thought is unmisteakeable. In Houser's words, he "had come to believe that attunement to nature was the key to the advancement of knowledge, as it was for life itself" (Houser 1998: xxxii-xxxiii). But he can not be considered a "reductionist", whether it be in the materialist or in the idealist sense. Indeed, Peirce rejected both materialism and idealism: "the former makes the laws of mind a special result of the laws of matter, while the latter makes the laws of matter a special result of the laws of mind" (*CTN* 1: 200, 1893). Instead, he stressed the *continuity* between matter and mind: "*Materialism* is the doctrine that matter is everything, *idealism* the doctrine that ideas are everything, *dualism* the philosophy which splits everything in two. In like manner, I have proposed to make *synechism* mean the tendency to regard everything as continuous." (*CP* 7.565, c.1892).

Peirce's reflections on continuity stem from mathematics and geometry, but he extended the principle of continuity to the human mind and the universe, as a reply to the inadequacy of mechanicist scientific explanations: "the universe is not a mere mechanical result of the operation of blind law. The most obvious of all its characters cannot be so explained. It is the multitudinous facts of all experience that show us this" (*CP* 1.162, c.1897). For Peirce, materialist explanations cannot account for the experienced mental realities of intention, purpose, and feeling, nor can they satisfactorily account for the irreversibility of phenomena of "degradation of energy" described in the second law of thermodynamics (Parker 1998: 201). Not reduction, but continuity is the key notion which makes Peirce our contemporary in our attempt as scientists and semioticians trying to understand complexity:

> Continuity, it is not too much to say, is the leading conception of science. The complexity of the conception of continuity is so great as to render it important wherever it occurs. Now it enters into every fundamental and exact law of physics or of psychics that is known (*CP* 1.62, c.1896).

For Peirce, all phenomena of our experience, all actual events involve the three elements, the three categories which are inherently and utterly irreducible to each other. The categories

> are conceptions of complexity. That is not, however, to say that they are complex conceptions. When we think of Secondness, we naturally think of two reacting objects, a first and a second. And along with these, as subjects, there is their reaction. But these are not constituents out of which the Secondness is built up. [...] while Secondness is a fact of complexity, it is not a compound of two facts. It is a single fact about two objects. Similar remarks apply to Thirdness. (*CP* 1.526, 1903)

Of the most important characteristics of thirdness is that, according to Peirce, thirdness is always related to habit taking which is essentially a continuous process. Thus, characteristically, Peirce points out that "it seems to be a universal property of protoplasm [which is one of the simplest natural expressions of complexity], intimately connected with the property of growth, that it takes habits" (*CP* 6.280, 1893). No wonder then that the same should apply to complexity as it appears in all the forms of human experience, even in its simplest forms. This may explain why mechanicism which tries to explain natural phenomena in terms of rigid laws, is totally incapable of dealing with the continuity between mind and matter (*CP* 1.162, c.1897), which is so deeply characteristic of our daily experience, of the communication between human beings, and of growth in every sense, but specially in the sense of a process of habit forming and learning.

4. Consequences of Peirce's approach to complexity

Ilya Prigogine has credited Peirce's view of time and of the second law of thermodynamics with being a remarkable anticipation of the *new physics*. He stated that "Peirce's metaphysics was considered as one more example of philosophy alienated from reality [...]. Today, Peirce's work appears a pioneering step toward understanding the pluralism involved in physical laws" (Prigogine and Stengers 1987: 302-303; Brent 1998, 175-176). Kevelson writes that Prigogine "is thoroughly Peircean when he speaks of a new attitude in science's description of the natural world" (Kevelson 1993: 284). For his part, Ian Hacking considers Peirce as a thinker with a very advanced position in respect to the issue of indeterminism, and also a pioneer on the metaphysical level on the turn of the century (Hacking 1990). But instead of pursuing the topic of Peirce's anticipation of contemporary physics, I will now turn my attention to some consequences of Peirce's approach to complexity in other areas of great interest: 1) abduction and creativity, 2) semiosis, and 3) cross-disciplinarity and communication.

4.1. Abduction and creativity

One of Peirce's most original contributions was his introduction of *abduction* or *retroduction* as a third mode of inference besides the two traditionally recognized methods of deduction and induction. Abduction is the process by which we engender new ideas, explanatory hypotheses and theories, both in the field of science and in everyday life (Génova 1997). "Abduction", writes Barrena, "is a reasoning by hypothesis, that is, a reasoning by means of an explanation which arises spontaneously upon considering that which in each circumstance has surprised us" (Barrena 1996: 33). Abduction is the key to innovation. It starts from facts and broadens our knowledge by means of explanatory theories. Abduction is not merely a "logical operation", but it is rather, from a semiotic point of view, that spontaneous activity of the mind which makes the strange familiar. Here is one of Peirce's examples,

> if we should find that this object which seemed white, in the first place was white, and then that it was a crow, and finally that all the crows known were black, then the fact of this seeming and really being white would require explanation. It might be an albino, or it might be some new species or variety of crow. (*CP* 7.198, 1901)

The whiteness of the animal is not in any way complicated, but it breaks our expectations and demands an explanation. Our spontaneous abduction consists of taming the anomalous fact that surprises by formulating some possible assumption from which the fact could be derived. Our abductive reasoning is continuous with nature's logic by virtue of which novelty enters the world (Anderson 1987: 50).

4.2. *Semiosis*

The three categories of Firstness, Secondness, and Thirdness correspond respectively to the basic triadic classification of signs into qualisigns, sinsigns and legisigns. James Lizska has argued convincingly that a Peircean sign theory can offer a unique solution to the problem of how meanings are generated. The theory suggests that "complexity and sign formation are integral. Put as a thesis, the argument is that the very conditions required for complexity happen to be those conditions Peirce articulates as formative of a sign" (Liszka 1999: 313; 1998). Though I will not argue the point in detail, I would suggest that the theory make sense of the processes where meaning is generated, while staying within a framework which is both naturalistic and non-dualistic:

> Meaning occurs in the transformation of the source-mediator-reader process into an object-sign-interpretant relation. These occurs when there are three processes available to some agency: mediation, directedness, and interpretation (Liszka 1999: 341-342).

Something in the same vein was argued tentatively by Walker Percy in his theory of language, and very recently by Floyd Merrell (Merrell 1998: 284). According to Percy, if we follow the lines sketched by Peirce, it is possible to gain a proper understanding of the articulation of thought and world in language, because meaning only emerges within the interaction of these three elements: thought, language and world. When a two-year-old child looks at a flower and babbles "flo-wa", he is coupling in his conduct the flower, the sound, his mother as the addressee of the expression, and himself as the builder of the coupling. The complexity of this habitual communicative process cannot be explained dyadically. For any dyadic explanation of communication denatures the process and thus makes real understanding impossible (Percy 1989: 86; Nubiola 1998).

4.3. *Cross-disciplinarity and communication*

Last, but not least, I come to the final point of my lecture. There is a trend in evolutionary theory and sociobiology according to which the human mind is believed to have evolved as a means of coping with environmental complexity (Godfrey-Smith 1996; Maclaurin 1998). This might be called a pragmatist thesis, the source of which may be traced back to Spencer and Dewey, but not properly speaking to Peirce. For Peirce the main evolutionary force is not adaptation, but love. Perhaps that sounds strange to our positivistic ears, but in Peirce's paper of 1893 entitled precisely "Evolutionary Love" he explains his doctrine of *agapism*, the doctrine that love is operative in the world (*EP* 1: 352; Hausman 1974).

For this reason, my last point is that the main lesson that we may learn from Peirce about complexity in this huge cross-disciplinary congress is that we must listen to each other, in spite of our very different backgrounds and specialties, trying to learn from everybody, because "growth comes only from love" (*CP* 6.289, 1891).Therefore, let me finish with a very long quotation from a manuscript of 1905 which may very well provide us with a Peircean key which may be needed to further pursue research on complexity:

> What I mean by a "science", [...] is the life devoted to the pursuit of truth according to the best known methods on the part of a group of men who understand one another's ideas and works as no outsider can. It is not what they have already found out which makes their business a science; it is that they are pursuing a branch of truth according, I will not say, to the best methods, but according to the best methods that are known at the time. *I do not call the solitary studies of a single man a science. It is only when a group of men, more or less in intercommunication, are aiding and stimulating one another by their understanding of a particular group of studies as outsiders cannot understand them, that I call their life a science*. It is not necessary that they should all be at work upon the same problem, or that all should be fully acquainted with all that it is needful for another of them to know; but their studies must be so closely allied that any one of them could take up the problem of any other after some months of special preparation and that each should understand pretty minutely what it is that each one of the other's work consists in; so that any two of them meeting together shall be thoroughly conversant with each other's ideas and the language he talks and should feel each other to be brethren. (*MS* 1334, 11-14, 1905)[6]. (emphasis added).

Even if this conference fails to give us a unified conception of complexity, it may nevertheless bring us closer to the ultimate opinion provided we, as interdisciplinary scholars, unite in a spirit of Peircean agape with other as brethren, for love is a distinctive feature of truth.

Sources of Peirce's Texts

CP Peirce, Charles S. *Collected Papers of Charles Sanders Peirce*, vols. 1-8. Eds. Hartshorne, C. , Weiss, P. and Burks, A. W. Cambridge, MA: Harvard University Press 1931-1958.

CTN Peirce, Charles S. *Contributions to 'The Nation'*, vols. 1-4. Eds. Ketner, K. L. and Cook, J. E. Lubbock, TX: Texas Tech Press 1975-1979.

EP Peirce, Charles S. *The Essential Peirce. Selected Philosophical Writings*, vols. 1-2. Eds. N. Houser et al. Bloomington: Indiana University Press 1992-1998.

MS *The Charles S. Peirce Papers* 32 microfilm reels of the manuscripts kept in the Houghton Library. Cambridge: Harvard University Library, Photographic Service 1966.

W Peirce, Charles S. *Writings of Charles S. Peirce: A Chronological Edition*, vols. 1-6. Eds. M. H. Fisch et al. Bloomington: Indiana University Press 1982-99.

[6] This text was first published by Ken Ketner under the title "The Nature of Science" in Ed. Stuhr, J. J. *Classical American Philosophy. Essential Readings and Interpretative Essays*. Oxford: Oxford University Press 1987, 49-50.

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